

AVIATION WEEK

JAN. 16, 1950

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. . . NEWARK . . . NEW YORK International . . . NEW YORK
La Guardia . . . PHILADELPHIA International . . . PHOENIX
. . . RALEIGH-DURHAM . . . ST. JOSEPH, MO. (ordered)
. . . ST. LOUIS . . . SALT LAKE CITY . . . WORCESTER
. . . AMSTERDAM . . . BRUSSELS . . . CANTON . . .
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The exact sweep assigned to this Air Force fighter role is far behind enemy lines. Such missions demand the maximum in fuel economy, performance and reliability of the aircraft's power plant.

To meet these requirements, Lockheed selected Westinghouse J-34 Turbojets. Their small front

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J-34



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AVIATION CALENDAR

- Jan. 30-27-Fourth annual Air Transport Union Conference, conducted by American University in cooperation with CAA and ATA, Washington, D. C.
- Jan. 14-12-10th Texas Navy Industry meeting as annual conference and conference lunch, Washington
- Jan. 12-15-All American Air Museum, Miami
- Jan. 16-27-Massachusetts Air Cruise for private pilots, conducted by Florida Air Flight Assn.
- Jan. 16-19-East Massachusetts Show, sponsored by American Society of Mechanical Engineers and the Society for the Advancement of Management, Cleveland, Ohio
- Jan. 17-18-100th annual dinner of the Traffic Club of Philadelphia, Benjamin Franklin Hotel, Philadelphia
- Jan. 17-18-University of Illinois second annual Custom Sport Operators school, Urbana, Ill.
- Jan. 23-14th annual Home Night dinner, Hotel Astor, New York, N. Y.
- Jan. 25-26-14th 15th annual meeting, technical sessions, Hotel Astor, New York, N. Y.
- Jan. 24-North session, NCAD Council, Cleveland
- Feb. 14-26-National Sportsmen Show, Grand Central Palace, New York, N. Y.
- Feb. 27-Mar. 3-Airport meeting, American Society for Testing Materials and W. L. Iron Works, Pittsburgh
- Mar. 4-6-47th annual meeting, American Road Builders' Assn., Netherlands Inn Hotel, Cincinnati
- Mar. 24-25th annual flight propulsion meeting, sponsored by the Institute of the Aeronautical Sciences, Cornell Univ., Cleveland
- Mar. 26-30-National Finance Exposition, sponsored by Society of the Plastics Institute, New York, Chicago
- Apr. 4-6-Engineering and Maintenance conference, Air Transport Assn., Hotel Chesham, Kansas City
- Apr. 4-6-National Production Exposition, sponsored by the Chicago Technical Society, Cleveland, Stevens Hotel, Chicago
- Apr. 14-26-100th annual meeting, American Area of Airport Executives, Nell Rineer Island, Columbus, Ohio
- Apr. 17-19-19th aeronautics meeting, 3rd conf. of Aeronautical Engineers, Hotel Statler, New York City
- May 5-6-Midwestern conference on fluid dynamics and the national meeting of the American Physical Society, Reed Evans on campus, University of Illinois, Urbana
- June 10-11-National Aeronautic Assn. annual conference, Hotel Statler, St. Louis, Mo.
- June 26-30-7th annual meeting, American Society for Testing Materials, sponsored by Society of Mechanical Engineers and related equipment, Chalmers-Hallidie Bldg., Atlantic City, N. J.

PICTURE CREDITS

11-McIntire-Wills Photo Works, Inc.—Aerospace Administration Administration Co., Inc.—American Airlines

NEWS DIGEST

DOMESTIC

Confidentiality of Adm. Forest P. Sherman as Chief of Naval Operations was proposed to Jan. 19 by the Senate Armed Services Committee. Sen. William Knowland (R., Calif.) is pushing for a full inquiry into the ouster of Adm. Louis Donohue, Sherman's predecessor.

President Truman appointed Joseph J. O'Connor, Jr., as chairman of the Civil Aeronautics Board and Oswald Rees as vice chairman.

Bolzano pilot Elmer E. Erickson has been charged by the CAA with flying a civilian and military aircraft without CAA to revoke Erickson's pilot's license. Bolzano, Bolzano's director-general of civil aviation, piloted the P-51 which crashed into an Eastern Air Lines DC-4 last Nov. 1, killing 33.

Statement of complete aircraft totaled 2,149,106 in October, according to the Bureau of Census. That brought the year's total to 21,557,400 pounds—slightly higher than 1948. Of the total, 77 percent went to U. S. military customers. October shipments of civil aircraft totaled 273 aircraft valued at \$14.5 million. Total aircraft weight of civil aircraft for the 10-month period was off 37 percent, but value was off only 4 percent. Employment in aircraft plants in October was 165,695, down 2 percent from September. An additional 16,991 were employed in engine plants.

J. H. "Duke" Kinkadee, chairman of the board and chief executive officer of North American Aviation, Inc., was named president of the Institute for the Aeronautical Sciences.

Union and management committees at the Chrysler division of Chrysler-Wright Corp. jointly announced agreement on a renewal of their labor contract. The new two-year contract features a four-percent base increase, a compensated, guaranteed plan, and \$100,000 life insurance for each worker. Night shift hours have been increased from 10 hours an hour to 10 percent of hourly rate.

\$15,000 fellowships for advanced study in jet propulsion engineering are being offered by the Thrust and Flame Research Foundation. Three of the fellowships are for two years post graduate study at Princeton University and three at California Institute of Technology. Applications for the fall of 1950 may be obtained from the Daniel and Florence Guggenheim Foundation, 130 Broadway, New York, N. Y.

Pan American Airways has shifted 20 American mechanics to London in order to perform as much maintenance as possible as its Constellation at its English maintenance base. Carrier is using its Stratocruiser for most of the North Atlantic traffic, so, except for minor main engine pilots, which will be performed in Miami, Concord will be located in London. London also does maintenance on PAA's DC-6s.

Pilots of the Atlantic Division of Pan American World Airways voted to support a system wide strike vote of all pilots. Pan Am's contract with the pilots is a question and includes carrier's National Maritime Board. Two civil grievances charged by the pilots are (1) Pan Am was one of three pilots on Atlantic route as a negotiator, then violating a regulation which forbids a pilot to fly more than 12 hours on a single trip; and (2) Pilots of captain rank are being in compliance on the Atlantic route, while junior captains on other divisions continue to fly as captains. The captain flying as captain receives captain's pay.

James C. Zeller was elected to the presidency of the Society of Aeronautical Engineers for 1950. Zeller is chairman of the engineering board of Chrysler Corp. Air affairs of the society director were Kenneth D. Kelly, United Air Lines, vice president for its transport activity, Harold D. Hollister, CAA, vice president for aircraft activity, and Wright A. Perkins, Pratt & Whitney Aircraft, vice president for aircraft preproject activity.

FINANCIAL

Northwest Airlines last week declared the regular quarterly dividend of 254 cents per share on the company's 980,000 shares of 4-6 cumulative preferred stock. The dividend, totaling \$112,125, a payable Feb. 1 to stock holders of record at the close of business Jan. 20.

INTERNATIONAL

Airlines of Colombia (Aerovias Nacionales de Colombia) announced its planes flew 47,330 hours in 1949 and carried 6250,919 miles. American carried 55,657 passengers and 56,094 tons of cargo.

Lines of Colombia (Líneas Aereas Nacionales) is preparing to extend its lines to other countries. The company is negotiating for purchase of inventory equipment.



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PNEUMATIC AND HYDRAULIC SYSTEMS
HYDRAULIC SYSTEMS • ELECTRIC PUMPS

Air Power Comparison

Number of Aircraft Authorized	1950	1951
U. S. Air Force	12,110	13,135
(23.5 million lb.)	(23.5 million lb.)	(23.5 million lb.)
U. S. Navy	768	769
(5.9 million lb.)	(8.1 million lb.)	(8.1 million lb.)
Total	12,878	13,904
(104.4 million lb.)	(31.6 million lb.)	(31.6 million lb.)

Recommendations for Minimum Military Aircraft Annual Requirements

Air Conditioning Committee (1949)

Minimum aircraft world power in well rounded
Minimum to compete in maintaining world peace

President's Air Policy Commission (1948)

Recommended for 1948: 36 million lb.
Recommended for 1949: 50 million lb.
Recommended for 1950 (Major re-evaluation of entire program in light of existing circumstances. No such re-evaluation is being made. USAF spokesmen say.)

Coordinated Aviation Policy Board (1948)

Total strength to mount a successful air offensive requires annually: 111 million lb.
Strength necessary to present less of a new target annually: 61 million lb.

United States Air University Study (1948)

Annual increments to provide base for expansion: 10 million lb.

XF-91 Completes Phase One Tests

Republic Aviation's new XF-91 high-speed Air Force interceptor has successfully completed its Phase One flight tests at Edwards Air Force Base, Minn. Calif. Approximately 40 flights were completed with company pilots and crew in charge, and the craft has been turned over to the Air Force for Phase Two performance tests to be handled by Maj. Richard Johnson, holder of the world's official speed record.

During the plane's first flight around oval apparatuses were made with data lowered. Still speed attained was so low that the "chase" airplane monitor for the flight could not catch XF-91's still slower on push and pull. Fuel and lateral control in stalls is attributed to the wing's severe twist. Company says that wing and tail wingcraft rendered excellent stability under all conditions, while the plane's lateral control permitted slow, lateral control while maintaining good "hold" qualities.

The craft's variable incidence wing operated for the first time in flight proved to be easily movable from a central standpoint, according to reports, and was operated through the maneuvers stage with no malfunctions. Other flight tests included investigation of vibration, stability at higher speed ranges, afterburner thrust and the after burner system. High speed dives were conducted with the XF-91 engine alone, the first motor motor not having been fitted.

Lightplane Market

Post Aircraft Corp., with a total of 12,135 airplanes produced, led the lightplane industry in shipments for the year 1949, followed by Cessna Aircraft Co. which shipped 157 planes. With dollar total not yet completed, Cessna led Piper in dollar value of shipments for the year.

Post's official totals compiled last week showed approximately 1570 shipped by 12 manufacturers during the year, or less than half of the 1949 shipment by the same group in 1948, and barely more than a tenth of the 33,234 shipped by the lightplane makers in their best year, 1946.

Aeromac Aircraft Corp., No. 3 position with 311 planes, rated Best Aircraft Co. reporting 254 Ryan Aeronautical Co. was fifth with 215 planes. Sixth was the bankrupt Locomotive Airplane Corp. which shipped 156 planes before it closed its doors last summer.

Civil Aviation Budget Box Score

Agency	1950 Fiscal Appropriation	Proposed 1951 Supplemental	1951 Fiscal Recommendation
Civil Aeronautics Board	\$1,623,500	\$100,000*	\$4,375,000
Civil Aeronautics Administration	140,825,962 (Plus \$67,300,000 contract authorization)	3,811,300* (Plus \$4,500,000 for Alaska airports, pending enactment of relieving legislation)	212,555,000 (Plus \$70,161,000 contract authorization)
National Advisory Committee for Aeronautics	\$5,000,000 (Plus \$10,000,000 contract authorization)	\$500,000 (Plus \$15,000,000 contract authorization)	\$7,500,000 (Plus \$17,000,000 contract authorization)

* To absorb pay increases

More Money for Flying Aids

Big increases asked for CAA and CAB, with airports and airways scheduled for most of additional funds.

Federal appropriations for federal aviation activities are proposed in the President's 1951 fiscal year budget. It recommended:

• Civil Aeronautics Administration, \$21,316,500—\$12,513,500 cash and \$70,161,500 contract authorization. The need for CAA's 1950 allocation at \$20,715,902 (\$14,015,902 cash and \$67,300,000 contract authorization), budgeted in the 1950 bill, by \$75,990,598. It would open up 424 new positions, increasing the total number of permanent CAA posts from this year's 15,324 to 15,748. Recent test results would go to Radio Technical Commission for Aeronautics' all-weather flying program, both "transmission" and "altitude" phases, and for airport development.

• Civil Aeronautics Board, \$4,375,000. This at \$72,500 over the Board's \$15,020,500 for the current year, would increase total CAB position from 662 to 746.

The President's fiscal recommendations for funds were accompanied by two requests for legislation aimed at curbing government outlays for aviation.

• Separation of subsidies from service and payments to carriers was urged by

the White House for the first time.

"The overall rise in total annual payments to an estimated level of about \$275 million in 1950 has made it increasingly apparent that the subsidy element is separately identified." AL



Based on CAA trying to employ Proteus turboprop engine and has pushed up target date delivery of a complete set less the amount of 1950 to the spring of 1951. Semiconducting plane to use the turboprop in its Pressurized flying boat. Big wing in

though continued subsidy and "is required for the present," the President stated, "the industry should be expected to become increasingly self-supporting in the near future." The President also asked the Board to check down on subsidies under the present system of aid pay.

The subsidies by which subsidy rates are determined under existing legislation are their next review. While a considerable gain in efficiency has been achieved by the law since the end of the war, there are undoubtedly important opportunities for further improvement. The 1951 budget will permit the CAB to conduct more extensive investigations of airline efficiency, and to develop operating cost standards.

• Unified program. The President recommended would submit legislation to unify promotional and regulatory activities of the government for various forms of transportation after reviewing the report of Secretary of Commerce Charles Sawyer outlining the areas involved. Sawyer's report (American Ways, Dec. 22) implied that government promotion had added subsidies at the expense of railroads, also vital to the national defense.

He also suggested new rules for government-financed transport facilities, so that programs the public did not value highly enough to pay for could be continued.

Following is a breakdown of the 1951 fiscal year budget proposed for CAA.

• Salaries and expenses, \$14,216,000. This compares with \$14,462,130 for the current year.

• Air transportation facilities, \$68,961,500—\$40,020,000 cash and \$28,941,500 contract authorization. This compares with \$44,402,000 (\$13,025,000 cash and \$30,377,000

1951 in support, and 1946 in Naval Reserve. Total Navy strength on June 30, 1951 under budget is expected to be 174,500 Navy personnel and 71,000 Marines, a total of 446,400 military personnel as compared to 522,000 as of July 1, 1949.

• Active inventory—Comparable figures by the USAF show that an active inventory of 5390 airplanes is expected to be maintained in fiscal 1951.

• Chairman Carl Vinson of the powerful House Armed Services Committee is expected to set the tempo for any congressional action to seek additional air power appropriations. Vinson last fall in the closing days of Congress urged adoption of a bill to act as a congressional check on the President which would require his getting congressional approval when he withheld defense funds which Congress had appropriated.

• Budget Analysis—Analysis of the USAF budget shows the following allocations:

• New aircraft, \$1,965 million;
• Guided missiles, \$17 million;
• Electronics, \$115 million;
• Industrial mobilization, \$18.9 million;
• Weapons and ammunition, \$92.5 million;
• General purpose vehicles, \$21.8 million;
• Special AF equipment (photographic, ground facilities, meteorological, and test equipment) \$22.5 million.

• Training aids, \$11 million;
• Research, \$32.8 million;
• Development, \$120.7 million;
• Operational engineering, \$12.4 million.

• Management and operation studies, \$75.5 million;
• Air Reserve, \$75.7 million;
• Air ROTC, \$10.6 million;
• Air National Guard, \$101.9 million.

• Navy Readiness—Navy budget study on Navy the following distribution of proposed allocations:

• Aircraft, \$635.0 million;
• Fleet aircraft, \$13 million;
• Technical equipment for service train, \$1.7 million;
• Aircraft modernization, \$28.6 million;
• Outboard for new aircraft, \$15.2 million.

• Research and development, \$20.3 million;
• Maintenance of aircraft facilities, \$10.4 million;

• Installation and maintenance of aircraft devices, \$1.4 million;
• Flight operations and maintenance, \$410.5 million;

• Industrial mobilization, \$4 million;
• Supporting aeronautical equipment control and services including photographic equipment, weather instruments, evaluation of new electronic equipment, etc., \$20.8 million.

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AERONAUTICAL ENGINEERING

Causes and Control of Powerplant Surge

Analysis of adverse operating characteristic in ducts, compressors, diffusers shows way to attack problems.

By R. B. Pease*

Surging in aircraft compressors, diffusers and ducts is a vital operational consideration. The condition must be avoided not only because of destructive vibration set up, but also because of loss of pressure recovery in these components.

Magnitude of the vibration can cause failure of lightly stressed aircraft parts. And loss of pressure recovery reduces power output of the propulsion system and even fuel economy.

Surging is the pulsating flow condition occurring during operation of a compressor at reduced flow. The mechanism of the surge can be explained with the aid of the compressor steady flow characteristic, that is, a diagram showing variation of pressure of air delivered with the mass flow rate delivered.

Two conditions always exist when surging occurs. The characteristic of the compressor has a positive slope, that is, pressure decreases with decreasing mass flow, and the receiver volume is appreciable compared with the compressor volume.

► **Stability Characteristics.**—Variation of compressor pressure ratio with flow rate is shown in Fig. 1a. In Fig. 1b, the pressure ratio at the inlet of the receiver or piping is depicted as relation to the flow rate into the receiver. For steady flow conditions, the flow out of the compressor is at the same rate as the flow out of the receiver. If the curves are superimposed, the intersection of the receiver and compressor characteristics represents the operation point.

If steady flow characteristics are used, it is seen in Figs. 2a and 2b that the one displacement from equilibrium (c) there is a tendency of the system to return to (c). Thus, if the compressor suddenly begins to operate at a flow rate (c) greater than that at equilibrium (a), the reverse of the desired pressure by the receiver (c) over the supply by the compressor at (c) imposes a decelerating force on the air

columns and will cause the flow rate to decrease towards (a), since desired pressure is greater than supply pressure.

Also, for a tendency towards a lower flow rate (e), the excess of available supply pressure from the compressor at (e) over the desired pressure of the receiver at (e) superimposed accelerating force on the air columns and will cause the flow rate to increase toward the operation point (c). This tendency to return to equilibrium is called stability.

That surge occurs when the equilibrium point is on the slope of the compressor characteristic (Fig. 2b) may be explained by considering the dynamic response of the receiver. Since the receiver has a certain accumulation volume, when a compressible fluid such as air is used, some air may enter the system through the receiver inlet then is discharged at the receiver outlet at a given instant. Dynamic and steady state characteristics are the same for the compressor, because of the very little effective accumulation volume. If the compressor delivers no excess air flow suddenly, it will be accumulated automatically in the receiver and the pressure there will increase slightly.

This phenomenon is illustrated by the dotted lines on Figs. 3a and 3b. As the flow rate out of the compressor increases momentarily, the pressure in the receiver (Fig. 3b) rises only slightly in (c), but the compressor is capable of delivering air at a higher pressure (a), hence the system is unstable. The system in Fig. 3a is still stable since the pressure raised (a) is greater than that which the compressor can supply to (a).

This suggests a criterion of stability. When the dynamic characteristic of the receiver and ducts assembly has a slope greater than that of the compressor, no operating system combining the two characteristics is stable. When the receiver duct slope is less than the compressor slope, the combination will be unstable.

► **Surge Cycle.**—Mechanism of the surge cycle can be described with the aid of Fig. 4. Surging operates at any point 1, 2, or 3, it is essentially the same.

The cycle starts at (a), pressure builds up in the receiver, with the compressor delivering air according to its characteristic. Air is pumped into the

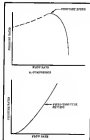


FIG. 1—STEADY-FLOW CHARACTERISTICS

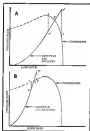


FIG. 2—STABILITY OF SYSTEM NO RETURN TO 100-150 Lb./Sq. INLET P./Sq.

receiver while the compressor is operating along the characteristic flow (a) to (b). From (b) a reduced flow rate is required, and is attempting to follow down the left side of the characteristic to (a), the compressor is delivering less pressure than is already present in the receiver.

*Institute of Experimental Aerodynamics, Aeronautical Laboratory, American Airlines, Inc. These researches were done in collaboration with Dr. W. C. Rindell, Northrop Aircraft, Inc.

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FIG. 3 DYNAMIC CHARACTERISTIC CURVE (AN INDICATOR OF INSTABILITY)



FIG. 4 RECOVERY OF A SURGE CYCLE

Flow out of the compressor stage and begins to move—air begins to flow from the higher pressure in the receiver back through the compressor. When this begins, the compressor is no longer operating on the characteristic in (a) but is now operating at (d), the no-flow condition.

Since (d) is at an even lower pressure than (c), air continues to flow out of the receiver until the pressure there has dropped to (f) and eventually to (a). When this happens the cycle is completed and another cycle starts at (a).

Surging Bernhardt-Studier* have indicated that frequency and magnitude of surge pulsations are affected by the volume of the compressor and receiver systems. It was noted that an increase in volume resulted in an increase in amplitude and a reduction in frequency of the pulsations. Measurements* were reported showing that a fluctuating flow at the inlet of the compressor has little effect on the location of the surge point.

Another report* verified that the compressor and receiver systems played a role

in that the pressure pulsations were frequently non-sinusoidal and that there was a transition between stable and surging operation in which there were erratic pulsations of smaller magnitude than the surge pulsations.

It was concluded that attempts to extend the surge-free range of a compressor or reduce the magnitude of the pulsations must be done on the actual installation with which the compressor is to be used.

Reduction of the positive slope of the compressor characteristic curve or change of the receiver capacity of the receiver may prevent surging. The position of the compressor characteristic at which surging would start was quite conservative relative to the test fluid* but made a qualitative analysis of surge with the additional aid of a steady-state dynamic analysis of electrical circuits. However, no experimental methods were suggested to aid in prediction of the surge point.

Predicting Surge-Free simple systems which have no variation or distributed volume (long pipe lines) between the compressor inlet and the large accumulation volume at the receiver, the dynamic characteristic slope can be predicted from qualitative considerations. If the flow rate was suddenly increased in the system, the pressure at the compressor outlet would not increase instantaneously, since with no distributed volume or resistance (no resistance), using the electrical analogy introduced in Ref. 6) there is no increase in pressure acquired for the increased flow rate into the receiver.

The pressure increases gradually as the accumulation volume fills up, but instantaneously the slope of the characteristic is zero ($\frac{dp}{dQ} = 0$) it is this instantaneous slope of the characteristic which determines the stability criteria.

If the system to be analyzed is not simple, but has a length of piping which contributes distributed air volume and flow resistance to the circuit between the compressor delivery and the accumulation volume, then the dynamic slope may have to be determined by experimental means.

Our work needed makes use of a rather unorthodox assumption that the dynamic slope can be measured with no flowing. Based on the criteria stability and this value of the dynamic slope can be used for any flow rate through the system.

The exit ductwork of the system should be connected to a receiver which has been slightly oversized. All parts of the system such as throttles, piping, etc., should be placed in operating position. A diaphragm is the entrance of the system is burst and the time rate of pressure increase in the accumulation vol-

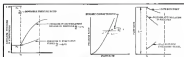


FIG. 5 EXPERIMENTAL RESULTS OF THE DYNAMIC SLOPE

ume is measured accordingly.

This rate is directly proportional to the difference in flow rate at which the accumulation volume is burst as through the exit throttle and is being filled through the burst diaphragm. The time rate of pressure increase in the receiver would give the rate at which air flows into it.

Since the receiver has no flow rate will be the rate at which air flows into the system through the burst diaphragm (Fig. 5). The pressure ratio represented at the inlet at the beginning of the test is the pressure ratio increment used to determine the dynamic slope. The rate of this pressure ratio increment to the flow rate into the system is the dynamic slope required.

Surge Prevention: The system with long piping connected to a receiver, compressor in Ref. 5 is essentially the same as the type described above. In experiments with this system, the researchers found that the surge last occurred at a point on the characteristic which had a positive slope of some magnitude.

This condition qualitatively the stability criteria stated above and suggests that surging can be delayed by increasing the dynamic slope of the receiver-throttle characteristic. This is done by increasing its distributed volume and flow resistance (or in the electrical analogy, its impedance).

When piping between the accumulation volume and the compressor delivery then will delay surging to a steeper value of the compressor characteristic slope, since the receiver-throttle characteristic slope is decreased. This method of control permits the pressure delivered at the receiver-throttle, since there are more losses due to friction through the added pipe.

Another method which delays surging, or prevents it altogether, is that of changing the compressor characteristic to have a negative slope over all or most of the flow range. This can be done by changing the compressor blade design (Fig. 6, characteristic (a)).

A more efficient method is to reduce the losses in the low flow range as is characteristic (c) of Fig. 6. This tends to surge somewhat, but surge will occur at the very low flow rate. The characteristics (a), (b), (c) of



FIG. 6 MODIFICATION OF THE COMPRESSOR AND ITS CHARACTERISTIC CURVE TO DELAY THE SURGE-FREE RANGE

Fig. 6 will have the same pressure ratio history, because the air is being accelerated uniformly through the machine, creating losses of pressure.

If an auxiliary valve is used to bypass part of the delivered flow, curve (d) can be changed, since the compressor is operating at point (a) but the air being used by the receiver-throttle system can be adjusted to any value by regulation of the bypass. This method is commonly used for regulation, but is not suitable at low flow rates, since no useful power is compressed air is being wasted through the bypass.

Still another possible solution to the problem is to reduce the accumulation volume to such a small amount that the surge frequency is so high and its amplitude is small that there is no danger in surging operation. The super-sound whistle is an example of such a device. The surge frequency is so high that the audible range and the pressure amplitude is not dangerous to structural parts.

Super-sound Inlet Diffuser-A phenomenon observed in supersonic inlet diffuser tests has all the characteristics exhibited by centrifugal and axial flow air compressors during surging operation. The phenomenon has been termed "buzz" because of the sound emitted during the process. It was initially attributed by Oswatitsch* and he was among the first to describe the phenomenon as "buzz" or "transonic Geströsse".

He took up pictures (buzz duration between .5 and 5 milliseconds)



Small truck is used to move wing, tested with 30,000 during development of Boeing, B-1.

UTILITY

Whether crated vehicles or a huge half truck pentamail casing, key for increased low-back or lift-for evacuation of wounded, transport of replacement troops to forward areas or personnel to jump areas — loading and unloading will be simple — safe, speedy delivery assured.



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a level, rather than inclined, attitude.

Since the auxiliary engine provides the thrust which normally would be supplied by the rotor, the feathering requirements of the rotor are relaxed, consequently flapping of the blades is also limited. And vibration in flapping which reduction in vibration from this source.

• **Version Planned**—The proposed rotor version is proposed as an emphasis of using sealed fuselage and drive shafts, the latter functioning as spacers.

Craft would be powered by two 175 hp Lycomings mounted along the wings and during both ascent and propulsion, with shafts to the rotor through streamlined struts. It is intended that the configuration will be capable of single-engine performance in a helicopter.

At low speeds and for landings and takeoffs, the craft would perform as a helicopter, with the rotor propeller detached, but for forward flight, propeller would be engaged, the wing picking up lift to unload the rotor, and the Lycoming engine providing forward thrust. With transition complete, the major portion of the lift would be carried by the wing, the rotor functioning for lateral control only.

• **Cruise At 250**—Normal gross weight is expected to be 6000 lb., cruising speed, 150 mph at 5000 ft., top speed, 162 mph. The craft is projected to accommodate 6 liters or 1000 passengers for 8 passengers in addition to the two crew.

At alternate gross of 7500 lb. it would seat 10 passengers.

The design features clean-shaft doors at fuselage rear, together with lowering crane carriage and power hoist for loading in hovering.

Mounting of the engine outside of the fuselage will improve aerodynamic characteristics, providing for greater passenger comfort.

And because of the partial rotor operation to be employed, storage of the craft will be facilitated with the blades stowed in the forward-stay position.

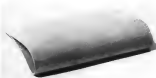
Overall height of the configuration would be 15 ft., rotor diameter, 50 ft., fuselage length, 30 ft.; wing span, 28 ft., unsharpened rotor would be 15 ft. long, 34 ft. wide, and have a 6-ft. tip area.

Production plans are not yet complete, but the company expects to have an active version prototype ready before end of 1959.

A technical presentation of this craft, bearing a 25,000-lb. gross, is being planned in cargo-truck carrier/capable landing planes, with cruising speed estimated at over 200 mph.



Stages in forging turbine blades.



Forged turbine rotor.



Blade drilled from raw powder.



Parts produced from Mervet process.

Factors In Gas Turbine Blade Production

Study of methods for creating variety of blading show benefits for each, but choice may be narrowed.

In the event of a national emergency, it is probable that over 33,000 gas turbine engines per month would be required.

Assuming that three-fourths of these would have axial flow compressors, the monthly quantity of compressor rotor and stator vanes would be about 25 million, turbine blades about two million, and nozzle vanes would number about 15 million.

It is apparent that this large volume of blades could be obtained only by processes giving maximum productivity. Such processes should require a minimum of critical materials, use less labor (skilled and unskilled),

and space. Equipment needs should be studied carefully, particularly as to availability, rapid expansion of facilities and tooling and tool life.

Many processes of manufacturing blades and vanes are being pursued presently, and probably one or two of these methods will emerge with the best balance of all factors involved. It is likely that all will be used to some extent for production of certain parts for which each is suited particularly.

• **Forging**—The first blades used in U.S. jet engines of engines were made from comparatively rough forgings, finished by hand-polishing operations to an approximation of the desired aerodynamic shape. It was soon apparent that the original forging was much more uniform than the hand-polished part, and greater effort was directed towards meeting the finished part dimensions by the forging process.

This effort resulted in forging to

tolerances previously achieved only in the industry. For example, twisting edges of 430-945 in previously were considered the limit of possibility, but twisting edges of .000-.012 in. are now an regular production.

Actual cost was being held to within .005 in. of the mean.

Facilitating this work, has been the movement in forging technology, the design and the construction that has reduced costs to a practical figure.

Current portions of blades and vanes used to date have been made by the forging process, and the blade productivity at most of us it affords a broad background of experience, good repeatability, low cost and reasonably fast output.

A criticism of this process is that it uses heavy equipment and sometimes large quantities of dies, since the life for compressor blades averages 10,000 to 15,000 pieces and for turbine blades 1500 to 2000 pieces. Fortunately, present methods of die reproduction have reduced greatly the amount of drilled blades formerly required. However a high degree of skill continues to

be regrett in the operation of the process.

Loss-Wax Process. Many types of compressor and turbine blades are made by the well-known "lost-wax" investment casting process and this method has contributed greatly to the jet engine.

Using alloys which could not possibly have been machined or forged, perfectly flawless, large quantities of turbine blades and vanes have been made from high-temperature materials. This process is best adapted to small parts, both from the standpoint of mold cost and tolerance, but large turbine

blades and vane vanes have been made in quantity.

Reproducibility is excellent for small parts and wholly acceptable on turbine blades and vanes. This method is best suited to solid parts, although many hollow parts with simple interior surfaces have been made.

The process is more expensive than forging and does not permit the precise grain size and dimensional control possible with well-made forgings. However, this method is important in making parts of non-forgable materials and is useful for small quantities of experimental parts, since the scrap rate

does not waste much quickly, usually, than dies for forging.

Machining. Machined blades have been widely used in the past several years. The usual process depends upon depositing the form of a master from its own forging, using one of the common methods of molding or sanding.

Contrary to most other processes, the cost of forming device is usually the first machining operation on the forging and the article is formed, leaving from the rest. While the absence of stresses in control of axial force or shear, low-alloy steel as well as metal, is relative to the cost.

This process has good reproducibility with complicated irregular products. However, warpage and distortion during machining can occur, hence the method presents problems unless tolerances are adequate. Machined blades are ordinarily polished to a smooth finish.

Cost of these parts is usually greater than those made by other processes and, in view of the strong trend toward lower costs in gas turbine engine production, the method may not be widely adopted. For high production, it would require a large quantity of machine tools, always a severe problem in aircraft.

Forging. Forged blades are made by forming of sheet stock, with or without welding to complete the operation. The Germans made wide use of this process to achieve economy of material, weight and, in some cases, to permit air cooling of the blades. Large numbers of turbine vanes have been made in this way by the Germans.

Most fabricated blade materials have been in the low-alloy group and, as operating temperatures increased, many fabricated parts were replaced by castings of high-temperature alloys.

Renewed interest in low cost, light weight and air cooling, together with the development of high-temperature alloys in sheet form, promises to revive the use of fabricated parts.

In this process, the designer can do much to assist the manufacturer, since it is obvious that low twist, uniformity parts can be made very readily. However, it is possible to produce blades having considerable twist and all curved airfoil sections and wall thickness where such design is necessary. This is a typical cost, however in which the designer design will be the chosen and performance tests must define the design.

Development of fabricated blades for the compressor and turbine may have a very beneficial effect in an emergency production program because parts equipment is light, there is little wear of material, deformation and progressive die is usually possible for high production.

Two metals for high temperatures **INCONEL** **INCONEL "X"**

Offering exceptional hot strength and high corrosion-resistance, these high-nickel alloys solve almost "hot-spot" problems.

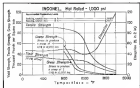
The extremely high temperatures generated within jet and gas-turbine power units are among today's most challenging aircraft engineering problems.

Relatively few materials are able to withstand the destructive combination of high temperatures, corrosive combustion products, and high stresses. Still further complicating the problem—many otherwise satisfactory materials are unsuited either because of high cost or inherent lack of availability.

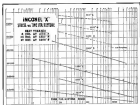
Among the few materials to show satisfactory performance in jet and gas turbine applications are *Inconel*® and *Inconel "X"*®. Both alloys have excellent resistance to corrosion and destructive oxidation at temperatures up to 3300° F. Both alloys are workable. And both alloys are produced in cast.

Inconel serves best where a high degree of oxidation resistance is required and where moderate hot strength is sufficient. Typical applications are—jet burner liners, exhaust systems, heater combustion chambers.

Age-hardenable *Inconel "X"* offers much higher hot strength up to 1900° F., in addition to oxidation-resistance, making it useful for turbine wheels, turbine blades, high-temperature structural members and fastenings, and for springs up to 1600° F.



INCONEL provides an economical answer to high-temperature metal problems where moderate hot strength is adequate.



INCONEL "X" is age-hardenable and offers exceptional mechanical properties as well as high resistance to destructive environments.

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The end is only the beginning

As these words are written, the twin-jet Cutlass, Vought fighter airplane, is nearing the end of a long hard trail of research, design, development and test.

For 32 years Vought has built conventional airplanes of proved design for the U. S. Navy. The Cutlass, however, was completely new — a radical departure from Vought's time-tested fighter aircraft. It has no tail and it does have swept-back wings, two logical developments which posed problems Vought engineers never before had faced.

The Cutlass is Vought's first twin-engine jet fighter. To save weight, the engineers incorporated more magnesium in its airframe than in any previous Vought design, and made extensive use of Vought's lightweight "sandwich" materials. To overcome the forces of high speed flight, they provided hydraulic boosted ailerons (combining elevator and aileron functions) and incorporated artificial "feel" to simulate the control forces the pilot would encounter in conventional aircraft. And, finally, they created an airplane that would have

superior speed and performance at high altitude, yet handle effectively at low altitude for carrier landings.

These experiments and many others in this advanced aircraft design offered a lot of challenges. But, they are about ready to pay off — because the Cutlass, which in 1945 was only a gleam in a designer's eye, is emerging as one of the nation's top fighters.

It is fast — as fast as they come. Its rate of climb is amazing and exceeding performance requirements. It is highly maneuverable even at speeds in the neighborhood of the speed of sound. It has the firepower to deliver a killing blow in combat. It is equipped with the finest and most modern in radio, navigational aids, pressurization, instruments, hydraulic controls and other cockpit equipment. Flight-wise, the Cutlass has proved to be a pilot's dream.

Now, it is ready to start down another long trail: production, refinement and actual service in defense of the nation.

Yes, the end is only the beginning.



The Vought F4U-4 Cutlass twin-jet fighter, latest and fastest in a long line of Vought airplanes that have played well their part in maintaining American air supremacy.

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SPEED

Top speed of the Cutlass is a military secret. But here's a hint — it's in the "over 550 mph class". And, it's not a one-attempt figure. At four hundred feet or a forty thousand, it will compare with anything in the air.

MANEUVERABILITY

The Cutlass can execute any aerobically maneuver like a hard jockey-kick. At one mile up, or eight, it can outmaneuver any existing bomber or fighter — and turn inside it.

RUGGEDNESS

Structural stresses has been built into this average Vought fighter. Severe and rugged tests have been imposed on it and it is clearly evident that the Cutlass is endowed with traditional Vought ruggedness. The Cutlass can give it — and "take it".

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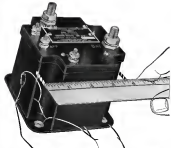


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The A-700A encrust tips the scales at only 2.5 lbs., gives rated operation from sea level to 50,000 ft. altitude in ambient from -67° to 160°F. Constructed from top quality materials only, the A-700A encrust has extra heavy duty contacts capable of interrupting their current up to 2500 amps—for longer service life, lower maintenance cost. Contact reinforcement is inherent.

Designed to close on differential voltage between generator and bus other than at a fixed voltage, the A-700A circuit is free from all contact flutter. Throbblesome receders and current-drawing bulbous tubes have been eliminated. The A-700A circuit operates with any d-c generator up to 300 amper capacity having a normal regulated voltage of 28.5 volts. 600-watt units also available.

^aManufactured as AN7005 (Spec. MIL-C-5076). Literature not reviewed.

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AVIATION WEEK ADVERTISERS AND THEIR AGENCIES

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1. *Explain the importance of the following factors in the development of a country's economy:*
 (a) *Human resources*
 (b) *Capital resources*
 (c) *Technology*
 (d) *Government policy*
 (e) *International trade*
 (f) *Infrastructure*
 (g) *Education*
 (h) *Health care*
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Look to the Sky



tag your market

**AVIATION
WEEK**

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Bridgeport 1, Connecticut, Est. 1937

NEW AVIATION PRODUCTS



Disk File

New type of disk file developed by Kennametal Inc., Lincoln, Pa., for use with steel, brass, nickel and plastics, is reported to provide faster, less costly operations, such as snagging, cutting, cutting off, facing and squaring up surfaces, etc., commonly performed by grinding.

Unsurpassed prices of hard Kennametal (90.3 Rockwell A) are compensated by fast of steel backing plate, a number of courses, to form many sharp, sturdy, cutting edges. They are shaped, ground, and polished in its precise 30-deg. negative angle, 30-deg. clearance angle, and 18-deg. negative radial side.

Construction is intended to afford most efficient and free-cutting action. Material is removed in shank chips, with no abrasive dust. It is claimed that smooth, flat surface is produced. Extensibility of intermediate courses of precise angles uniform cutting action assist face of workpieces. When the use of proper speed, workpieces are said to remove cooler than with abrasive wheels, because chips dissipate heat of cutting.

Four sizes are 6, 8, 10, and 12 in. diameter. Wheels may be mounted on grinder, abrasive disk machine, motor cut, or disk file machine with suitable adaptor. Recommended speeds range from 500 to 2000 rpm for hard metal cuts, and 800 to 1500 rpm for soft or grinding materials.

New Tool Steel

Recommended for such applications as brass extrusion die, dies and dies, valve extrusion die inserts, forging die inserts, forging punch dies and hot punch tools, a new metal, specifically designed for hot work, is announced by Allegheny Ludlum Steel Corp., Pitts- burg, Pa.

Marketed as B-47 hot work steel, it

key is a combination of chromium, tungsten, cobalt, vanadium and molybdenum in hot and cold tests to have high resistance to shock and abrasion at elevated temperatures.

Although hot hardness permits alloy to do heavy severe hot work jobs with out softening out or changing size, it is specifically recommended for applications requiring good toughness at relatively high temperatures, or where abnormal resistance and resistance to heat checking are important factors.



Absorbs Noise

Small, soundproof boards in which to mount instrumentation equipment usually affected by drop noise has been developed by Electronic, Inc., 415 Lexington Ave., New York 17, N. Y. Called Model M-15, and is of wooden construction, and lined with acoustic insulation board. Outside dimensions are 14 in. high and wide and 14 in. deep. By placing the instrument station in the sound booth, a high percentage of background noise encountered in shop are not transmitted.



Gate Valve

Adaptable for 75 psi, aircraft fuel system, small, lightweight gate valve (shown with electrical actuator), developed by The Parker Automotive Co., Cleveland, Ohio, also is available for service with high-temperature jet, for

oil, water-alcohol mixtures and other fluids.

Fabricated in sizes of 14, 14 in. (14 B) and 2 in. (24 B), units are made of welded alloy aluminum body halves, utilizing low pressure for making. Pressure-balanced seal does away with bulky components and maximum operating factors and wear.

At zero pressure, there is only light spring pressure on the floating seal supporting specially-compounded, fast-curing synthetic rubber element welded into rigid metal container. Low flow from either direction, low pressure acts on both sides of the seal, with only sufficient differential to accomplish a positive seal against gate.

Positive sealing is achieved to eliminate problems, usually encountered in synthetic seal, resulting from swell, shrink and cold flow effects. Minimum seal pressure prevents seal shrinking in closed position, no open position, seal is free from gate, allowing for simple dry storage without special attention.

Advantages reported from use of synthetic rubber seal. Wide temperature operating range (-65 to 155 F), low friction, and resistance to wear caused by sealless fuel.

Valve operates at pressures of 6 psi. vacuum to 75 psi, with low pressure drop—1.07 psi at 100 gpm, but the 14 in. valve size. Surge pressures as high as 150 psi are accommodated.

Welded valve body eliminates steel large body stiff and at potential source of leakage. Shells and gate seals are accessible from outside and may be removed without special tools. Gate travel is fully guided for positive action without binding or wear.

Valve is adaptable to manual operation, push-button remote control, or electrical operation using actuator furnished in any of several types. Optional thermal relief can be provided to bypass flow in the event of pressures of 80 psi or higher.

Valve opens and closes in 1 sec. with usual actuator (requiring no return line filter), but 25 to 50 sec. period can be provided by slow speed models to meet targets.

Small Capacitors

Miniature tubular capacitors, Type P55, offered by Aerovac Corp., New Bedford, Mass., had Aerovac improved solid water resistant, and better sealed with DuPont. Resulting "jackhead" paper-core tubular is claimed to offer heat and humidity resistant qualities associated with plastic devices, but at less cost. It can be used at 31.7 F. without drops, and dielectric strength is maintained at elevated temperatures.

"MASTER" JACKSTCKER IS LEDEX EQUIPPED!



LEWIS-SHEPARD Chase LEDEX ROTARY SOLENOIDS for RUGGEDNESS!

Lifting, lowering, moving and stretching these and four thousand pound loads dry in and dry out requires rugged, heavy-duty equipment. Just as rugged are the two 1/2" Lelex Rotary Solenoids built deep in the heart of the "Jackstcker's" powerful hydraulic lifting mechanism. The flow of oil in the hydraulic lifting mechanism is controlled by these two heavy-duty Lelex Rotary Solenoids, submerged completely in hydraulic fluid.

The same ruggedness required for this product is available for years. The five versatile uses of Lelex Rotary Solenoids may be found in many productive applications from automatic remote-controlled systems for engineering to automatic heavy lifting systems.

We supply to quantity users and advise the opportunity to be of assistance in engineering a Lelex Rotary Solenoid to meet the demands of your product.

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Airport Power that PAYS

Airport Handling 56,000 Airline Passengers in Year Keeps Shipshape with International-powered Equipment

Because the International tractor, purchased in 1936, proved to be so economical and dependable at the Rochester, Minnesota, Airport, a fleet of International tractors and International-powered equipment is now active on the "Goose."

Two International "4-6" tractors, with mowers bars for mowing grass areas, and plows for snow removal from runways and taxiways, are "Formal 7H" for forming perimeter areas which yielded 1600 bushels of wheat in 1945, a motor grader and a rotary snow plow, both powered by International diesel, comprise that fleet. Obviously, Rochester finds that International Power goes off through its dependability and long-term operating economy. See your International Industrial Power Distributor and get the power that pays six years longer.

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Power on Wheels and Gasolene Power

Whether it's needed: Shovel for heavy digging, power for the steadily growing oil pump or compressor, for the motor and pump for the International power, for the International power.



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WHEEL TRACTORS
DIESEL ENGINES
POWER UNITS



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SALES & SERVICE

New Plan for Aircraft Insurance

St. Louis firm making every fixed-base inspection station in effort to make coverage cheaper, simpler.

A new twist in aviation insurance, aimed at simplifying procedures, may pay off as increased business for fixed-base operators and lower cost to provide aircraft owners.

National Insurance Underwriters, St. Louis, Mo., in appointing every fixed-base operator as the agency at an office inspection station. These stations will inspect and report on aircraft owned by potential NIU policyholders.

Here's what happens:

► **Fair Payment**—NIU is advising every private aircraft owner in the U.S. that his fixed-base operator can perform the inspection, and attaching a simple advertising application for insurance. After filling out the form, the owner takes it to his fixed-base, who serves five quotations and returns the blank to the owner. Only half the annual premium is required by NIU when the application form is returned. When full premium payment is received, the fixed-base operator receives \$5.10 per NIU.

Advantages of the system are apparent to look private plane owner and fixed-base operator. Rates for the insurance are considerably lower, semi-

annual premium payments cut down the amount of initial cash needed to use plane purchase, immediate claim adjustment is available by using the inspection station for claim service.

NIU thinks the fixed-base operator will profit under the plan, since he will receive payment for the inspection, aircraft sales potential will increase when insurance costs less and can be paid seasonably, service and accessory sales potential will be higher as new owners become acquainted with the operator.

► **Rates**—Insurance rates at NIU appear to be comparatively low. Typical charges:

► **Public liability**, \$5-10,000 policy limit, semi-annual premium \$5.64, \$10-20,000 policy limit, \$7, \$15-30,000 policy limit, \$7.95

► **Property damage**, \$5,000 policy limit, semi-annual premium \$7.06, \$10,000 policy limit, \$8.25, \$15,000 policy limit, \$9.51

► **Passenger liability**, \$5,000 policy limit per seat, two-place aircraft semi-annual premium, \$11.88, four-place semi-annual premium, \$13.88, six-place semi-annual premium, \$15.15, \$10,000 policy

limit per seat, two-place semi-annual premium, \$17.78, four-place semi-annual premium, \$18.85

National Insurance Underwriters, according to D. W. Kutz, president, who formed in 1945 by a group of fixed-base operators as a non-profit insurance company aimed at reducing the cost of aviation insurance and improving the service. It currently has in force over \$35 million of aviation insurance.

SAC Invites

Customer Criticism

Southwest Airservice at Dallas this year in reporting its position at sending customers a letter expressing comments and criticism on SAC service. With each letter in a form headed "We've We Done?" in which the customer is asked to put down his frank opinion. A stamped self-addressed envelope is attached.

Covering letter states: "As a result of answers to a similar questionnaire last year, we were given the 'gift' to use ourselves as critics. We are now thereby made a member of a widely helpful change. Naturally, we're proud of Southwest Airservice's constant expansion and progress in the field of executive aircraft maintenance and parts sales, but we're the first to admit that SAC's not perfect. We always have pointed from ideas advanced by our customers and credit these friendly critics with much of our success."

Southwest plans to make the feature an annual custom.

Copter Hunts Tuna

United Helicopters, Inc., Palo Alto, Calif., has set a production target of 1000 tons of tuna in a land-based crane, operating what the company thinks is a new rule offer for its aircraft.

Since now made after a three-month test in which the copter proved successful in hoisting schools of tuna and had to allow a record catch in about two-thirds the time of previous voyages.

The San Diego test fleet, with more than 100 tons hoist enough to accommodate 100 tons of tuna, had planes previously, but found the slow hoisting characteristics of the rotary-wing craft more suitable for the job.

Customer Delivery

Douglas Seaplane Charter Service is helping a Tacoma, Washington, lumber broker do business the easy way. Preparing to work at his waterfront home office from a downtown office, the broker says Douglas is planning to fly customers to his hotel door. The same deal works for weekend guests.



HILLER 360 CONVERTED TO AIR AMBULANCE

Two of these United Helicopters, Inc., air ambulances have been sold to the French government for use in the French Indochina. The CAA-approved craft are converted Hiller 360s, specially designed to pull up patients in inaccessible areas. A compact, foldable stretcher is mounted to each side of the helicopter and connected with the cabin. Cables down from out and around the front end of the rotor. The

ports medical attention down. A demonstration at San Francisco recently showed the advantages of the air ambulance for difficult rescue work. A Hiller 360 air ambulance made a ground rescue over a four-mile course. The helicopter got to the scene of the "accident," pulled up two patients, and returned in approximately one-quarter the time required by the ground ambulance.

AIR TRANSPORT

Airline Chiefs See Prosperous '50

"If" national income remains steady, traffic and revenue are seen continuing their climb, but at a slower pace.

Airline traffic and revenue should continue to show upward during 1950, but at a somewhat slower pace than the spectacular advance achieved in 1949.

That's the almost unanimous opinion of industry officials who are again vying to go into the crystal ball which looked to touch off the airline boom again during 1945-1949, or the steep upswing of last year. Optimistic predictions for 1950 all hinge on one key—"If"—continuance of a high level of general business activity, with national income no lower than in 1949.

► **1950 Prospects**—Air Transport Association forecasts year-up-1950 prospects that are:

► **Passenger volume** rises by both domestic and foreign airlines would continue moderately those of 1949. Rate of increase for 1950 is expected to be less than in 1949, but the factors which caused domestic airline passenger traffic to grow 14 percent in 1949, after holding level between 1946 and 1948, are not likely to be disrupted in a single year.

(Milton W. Arnold, ATA's vice president—operations and engineering, predicts an average annual traffic increase of 5 percent annually for the next 15 years. He said that the 1948 air traffic level may be doubled by 1963 and that there is a good chance it will be 2½ times the 1948 volume.)

► **Mail, express and freight ton miles** should also be slightly higher in 1950 than in 1949. Express volume, which dropped following implementation of air parcel post in September, 1948, made a comeback in the last half of 1949, and the trend may continue. Domestic freight on airlines, which soared nearly 35 percent in 1948, will probably continue upward at a slower rate this year.

► **Total revenue** between all the domestic trunklines in 1949 may be about 5 percent over 1948. (The 1949 revenue ton revenue gain over 1948 was 15 percent on the domestic trunklines.) Revenue will not rise in much as much, possibly gaining 5 to 6 percent. If moderate gain in operating efficiency can offset expected increases in certain operating cost items, the domestic airlines as a group should show a 1950 operating profit close to the 574 million estimated for 1949.

VIA explained that even in 1949 the current did not rate a low status in these operations, and that in 1950 longer profits equivalent to 1949 the current will still not be in a strong enough financial position to warrant substantial adversity.

► **TWA View**—Ralph S. Dawson, TWA president, only this month echoed VIA's views.

Dawson indicated that 1950 will be even better for air travel than 1949, Dawson declared. He contended, however, that this prediction could be kept if Congress and the Civil Aeronautics Board delay the industry a stable regulatory policy.

Domestically, Dawson asserted, air line traffic should be helped by several secondary or indirect factors, which have made first-class travel less expensive than first-class train travel, and have brought air coach ticket prices to the level of rail coach. "The international picture," he continued, "is even more encouraging in the light of continued recovery in western Europe, reduced costs to tourists resulting from currency devaluations, and the prospects of Holy Year in Rome."



► **COACH SERVICE PLUGGING**—Southwest Airlines' Schaefer of American Airlines' coach reservation department took to the press to bolster AA's coach service to Chicago and Los Angeles. Schaefer noted the new American Airlines' Coach Service in Texas System, in New York, describing benefits which benefited the service, the press and the airline.

The TWA president feels that within a decade nearly all long-haul passenger travel will be by air.

► **Passenger Position**—United Air Lines President W. W. Patterson, who estimated his company would show a \$2 million net profit in 1949, declared recently that earnings must be improved further in 1950 if the stockholders are to get a fair return on the money they invested. He said a \$3 million profit would be required for a 7 percent return on UAL's invested capital.

While Patterson anticipated a high level of business activity during first half 1950, he expressed concern over actions of competitors who "in desperation or frustration have introduced lower standards of service and lower fares which cannot be justified by any rational economic analysis." He predicted continued business-driving moves by competitors may force United to enter such service in the lesser of two evils. "If this should happen," he warned, "it could very easily destroy the industry's entire business structure and end up exactly where we were two years ago."

► **Coach Problem**—By contrast, National Airlines President G. T. Baker and Northwest Airlines President Cyril Hunter seemed more and optimistic which pointed to an coach expansion as contributing importantly to favorable traffic trends in 1949.

Baker told reporters last year passed the standards of low coach rates in bolstering the air travel market. He predicted increased traffic and improved operating results in 1950.

With the help of air coach, Northwest's domestic traffic rose in 1949 over 1948 was about twice as much as now shows to be the industry as a whole, Hunter reported. He noted NWA's traffic continued to increase, passenger loadings last year was up 25 percent, compared with an average of 12 to 15 percent for other domestic carriers.

► **Shunt Avoided**—"No more" Hunter stressed, "although some airlines reported a slump during November and December, Northwest continued through these months at about its working rate of increase over 1948." Last month NWA carried an average of 1,981 passengers a day on its domestic routes, compared with 1,054 daily in December, 1948, and 1,125 daily in December 1947.

Northwest flew 711,015 passengers on its domestic and international routes in the first 11 months of 1949, compared with 593,671 during the same 1948 period. The carrier's total revenue for the year was estimated at \$43,000,000 and the airline's net profit of \$2,035,017 before taxes at the first 11 months of 1949 compared with a \$2,552,016 net loss which went into the books in the year 1948 period.

Here's How They Did in 1950...

Domestic Trunklines

Traffic	1948	1949	% Change
Passenger Miles (000)	9,832,540	6,575,379	+11.9
Mail Ton Miles	37,929,922	46,772,181	+9.7
Express Ton Miles	29,746,883	27,044,282	-9.1
Freight Ton Miles	70,457,511	94,887,116	+34.7
Total Revenue Ton Miles	793,084,009	608,895,907	+15.0

Financial

Passenger Revenue	\$344,715,597	\$378,743,932	+13.1
Mail Revenue	45,857,511	47,599,020	+4.4
Express Revenue	9,950,409	6,515,766	-34.6
Freight Revenue	13,835,379	16,252,297	+17.8
Total Operating Revenues	413,352,896	499,112,495	+20.4
Total Operating Expenses	412,277,717	494,707,317	+23.7
Net Operating Income	2,075,179	25,405,178	+1215.0
Including nonrecurring gain or loss applicable to 1949			

U.S. International Carriers

Traffic	1948	1949	% Change
Passenger Miles	1,555,957,000	2,144,012,000	+37.9
U.S. Mail Ton Miles	16,446,354	15,872,171	-3.5
U.S. Mail Ton Miles—paid post	668,391	1,247,235	+86.9
Foreign Mail Ton Miles	3,994,941	4,399,949	+10.1
Express Ton Miles	41,147,563	59,367,349	+43.9
Freight Ton Miles	4,188,967	7,506,049	+79.1
Express Freight Ton Miles	4,779,327	5,101,489	+6.8
Total Revenue Ton Miles	268,171,594	348,709,837	+29.9

Financial

Passenger Revenue	\$334,715,597	\$378,743,932	+13.1
U.S. Mail Revenue—paid post	57,135,549	67,763,663	+18.6
Foreign Mail Revenue	8,435,493	11,924,978	+41.4
Express Revenue	18,475,237	28,651,573	+55.2
Freight Revenue	1,374,140	3,375,040	+144.9
Express Freight	4,134,467	4,957,445	+19.9
Total Operating Revenues	\$339,214,199	\$397,386,266	+17.2
Operating Expenses	\$325,285,955	\$370,321,344	+13.9
Net Operating Income	\$13,928,244	\$27,064,922	+94.3

Feeder Lines

Traffic	1948	1949	% Change
Passenger Miles	\$7,928,000	\$75,758,000	+84.4
Mail Ton Miles	351,984	419,500	+19.2
Express Ton Miles	109,570	105,200	-4.0
Freight Ton Miles	256,794	499,800	+93.0
Total Revenue Ton Miles	8,695,347	14,362,500	+64.1

Financial

Passenger Revenue	\$4,665,549	\$7,588,375	+63.9
Mail Revenue	11,243,140	13,483,756	+19.7
Express Revenue	71,788	112,401	+57.1
Freight Revenue	70,361	112,190	+58.1
Total Operating Revenues	16,262,100	21,496,722	+32.2
Total Operating Expenses	13,825,512	22,498,336	+64.4
Net Operating Income	\$2,436,588	-\$1,001,614	-41.1



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Justice Dept. Hits PAA-AOA Examiner

The U. S. Department of Justice has with clipped into the middle of the Pan American Airways-American Overseas Airlines merger case with sharp criticism of the recent Civil Aeronautics Board examiner's report which recommended approval of the deal (Aviation Week, Jan. 2).

Justice Dept. attorneys launched their attack by questioning the propriety of permitting Examiner Thomas Witte to sit on the case. They noted that Witte was examiner in the

original North Atlantic route case decided in 1945—and at that time had recommended against certification of TWA, which now opposes the merger.

"Exception is taken to what appears to be bias and prejudice on the part of the examiner in favor of the applicants (Pan American and American Overseas)," the Justice Dept. declared. It added that the report is "replete with statements of casual treatment of matters vital to the public interest and established national policies."

The Justice Dept. and Witte had failed to investigate and report on all keynotes of false testimony by proponents of the merger. It charged that the

examiner failed to give proper weight to a vast accumulation of evidence bearing on PAA's alleged monopolistic practices.

When Witte found that negotiations leading up to the merger agreement had been conducted "at arm's length," the Justice Dept. said conversations on the AOA side were secret and supported from certain company executives.

Accusing Witte of condoning PAA's alleged monopolistic practices, the Justice Dept. cited for a finding that the proposed merger will restrain competition, especially on routes served by TWA, and eventually result in establishment of a monopoly. It declared that the three-carrier North Atlantic route pattern was established by CAB and the President in 1945 for a specific seven-year period and should not be disturbed at this time.

Seaboard Files Ocean Cargo Brief

Ties between the U. S. and Europe and the Middle East total nearly 14 billion lb. in both directions and 645 million lb. of that is potential air freight. Seaboard & Western Airlines spokesmen have told the Civil Aeronautics Board.

Certification of an unbridled all-Atlantic air carrier as the North Atlantic route would make possible carriage of 8.2 million lb. of traffic during its low season, or just 1.3 percent of the air freight potential unexploited by S&W, the carrier claims.

►Cargo Breakdown—A brief supporting its application for a certificate of public convenience and necessity, Seaboard claims it has carried more cargo than any other of the certificated airlines. Its figures show that in 1948 Seaboard & Western transported 1,566,831 lb. ACN, 115,577 lb. Pan American Atlantic Division, 1,119,260 lb. and TWA, 1,175,136 lb.

Now operating under CAB's frequency and regularity restrictions, Seaboard says it has carried more than 11 million lbs. miles of freight and made over 780 crossings of the North Atlantic during its 75 months of operation.

►Routes Sought—Carrier's application requests authority to operate a demand-free service to London, southeast and central Europe and the Middle East as far as South Africa. It also says its intention is to seek an freight for international service only from points along the Atlantic seaboard and from the Great Lakes area, with terminal points at Boston, New York, Newark, Philadelphia, Baltimore, Chicago, Cleveland, Toledo, Detroit, Cincinnati, Detroit and Buffalo.

TWA Makes Its Bid For Holy Year Traffic

TWA is warming up to the battle for Holy Year traffic in Rome by offering all-expense, round-trip air fares at prices undercutting those previously announced by Pan American Airways and non-scheduled operators.

Pan American, under a charter agreement with TWA, Rome, a Catholic charitable organization, has proposed a \$695 New York-Rome "package" air fare with 10 days in Europe. Non-scheduled fares, under agreements with Holy Year Pilgrimage, Inc., another nonprofit group, contemplate a \$680 roundtrip, all-expense fare between New York and Rome if it can get an exemption for the flights from the Civil Aeronautics Board.

►Choice of Tours—But now TWA, in cooperation with the Bureau of Catholic Travel of Thomas Cook & Son, Inc., is offering a \$615 all-expense Holy Year tour which provides for two weeks abroad, with visits to Lourdes and Paris, in addition to Rome. A second newly announced two-week TWA package tour will include Rome, Genoa, Milan, Florence and Paris for \$625.

For pilgrims with very limited time to spend abroad, TWA has a special one-way, all-expense tour to Rome at \$592.

The regular roundtrip rate for air transportation alone between New York and Rome is \$745.

►Time Limit—All of TWA's new packages tours are available immediately, but travel must be completed by May 10 under the special 11-day limit restriction for agreement of the International Air Transportation Association, which provides as of course, roundtrip rate of use and reimbursement the regular gateway fare (Aviation Week, Dec. 19).

Persons traveling on TWA's all-expense tours will receive regular first class accommodations. They will also be furnished with ground transportation abroad, accommodations at five-star hotels, meals, sightseeing trips, and entrance fees to museums and other places of interest.

►PAA Attack—TWA's tour program is especially significant in view of Pan American Airways' recent allegation that TWA "is attempting to subvert low cost air travel to Rome for the Holy Year in the hope of leaving pilgrims to use TWA's (expensive) high-fare service."

The sale U. S. flag line contemplated for scheduled service to Rome TWA had sought a court injunction to prevent PAA from operating its Felix Baumgartner flights. The PAA, New York-based flights have been delayed, and action on the court injunction has been withheld pending a decision of the

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CAB's position is the matter (Aviation Week, Jan. 2).
PAA contends that TWA will be unable to meet the demand for air transportation to Rome during 1949 and that if Pan American's charter arrangements with Sabena Rome are rejected, many passengers will seek transportation via unscheduled airlines whose ticket rate in 1948 was over 15 times that of the scheduled airlines. PAA estimated that between 150,000 and 200,000 American Catholics will go to Rome this year, adding that lower priced steamship accommodations have been sold out.

Air Lines Ink Mediation Board

Cutthroat for aiding the National Mediation Board's help in settling labor disputes, before last exhausting direct collective bargaining a decision at U. S. or here in NMB's 19th annual report (ad column).

"In two easy disputes," the report said, "the board is called upon for mediation service in cases involving the making or changing of complete agreements. Such requests reflect the failure of the parties to use their best efforts in negotiating directly."

"Under the law, mediation is in order only after exhaustive direct negotiations fail to produce a settlement. Mediation should not be requested in cases where the parties have made only a perfunctory effort to settle their dispute."

The report acknowledged that the air transport industry is expanding rapidly and that labor has not been able to attain the stability in labor relations experienced by the railroads.

The 63 air line mediation disputes during the year ending last June 30 represented only one-fifth of the total number of mediation cases handled by NMB, yet they occupied one-third of NMB's mediation time. This indicates lack of sufficient bargaining in advance of NMB intervention, the report asserted. The board also stressed the practice developing in air line labor relations of stopping or slowing negotiations every year.

The number of air line bargaining disputes before the board has increased every year since the war. There were 33 in 1946, 38 in 1947, 50 in 1948 and 63 last year.

There are air line strikes occurred during the first year.

• The last half of the 49-month pilot strike against National Airlines, which ended Nov. 24, 1948.

• A one-day strike by flight radio officers against Pan American Airways last April 1.

• A brief, unorganized wildcat strike against Colonial Airlines.

There were two emergency boards, one in the National Airlines dispute, the other involving Northwest Airlines.

Six arbitration awards were handed down involving Braniff (three), Northwest, Capital, Missouri and Wisconsin Central.

There are 224 air line labor contracts on file with NMB. Eleven are with local unions, 49 with system associations and 164 with national unions.

U.S. Jet Studies Are Non-Standard

American Airlines' Vice President engineering, William Littlewood, speaking recently before the Society of Automotive Engineers, gave this description of what happened when he returned from the Berlin Air Show in Farnborough, September, 1949:

"Hardly had my office opened for business the day after my return from Farnborough, than the bell started ringing loudly, and my secretary announced a succession of manufacturers whose names and telephone I had not seen for some time."

"John de Pagen—Each produced a sheet of very general specifications and outline drawings of aircraft, all of which, singularly enough, were powered by jet. These were little planes, big planes, turboprops and turboprops, planes with and without cockpit—all types, all sizes."

"I could not help but recall the occasions and places where manufacturers (and others) have based on the operators as these positively responsible for the lack of standardization in transport aircraft. If these heavily concerned jet transport designs—or any reasonable portion of these—ever get riveted or welded into actual form, you will behold the greatest conglomeration of non-standard design ever."

PAA Furloughs 146 Pilots

Pan American World Airways has furloughed 146 pilots as a result of a seasonal lifting of air in business, the first move in this direction by the carrier since the war.

Since 1945, PAA explains, it was able to counteract the seasonal drop by route expansion moves that in 1949, with slight exception, the company showed little change in the direction. PAA Am's layoffs were in accordance with procedures outlined in its contract with the ALPA. The 146 furloughed pilots are now shuttling in New York and Chicago newspapers for non-union jobs.

American, TWA, and United also have furloughed pilots since war's end.



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Widow Files WAL Crash Suit

A damage action for \$31,257,000 against Western Air Lines, Inc., was filed before Superior Court at San Diego, Dec. 22 by Mrs. Elizabeth J. Bright, of El Centro, Calif., as administratrix of the estate of her husband, Fred B. Bright, Jr., who was killed on a Laguna NA plane crash Christmas Eve, 1946.

The action charged Western Air Lines with lack of proper operation of the plane. The complaint alleges that Bright was 34 when he was killed. It said he had a record for a peccancy of 142 years prior and that he was capable of earning \$300,000 yearly.

Delta Passenger and Freight Business Up

Delta Air Lines will show a 13.5 percent increase in passenger business and a 31 percent increase in freight for 1949, it was estimated by Ralph C. Parker, vice president of traffic and sales. It is estimated that Delta will have carried 515,390 passengers in 1949, compared with 457,644 in 1948. The company topped its previous record of 508,405 passengers set in 1946.

Revenue passenger-miles totaled 397,946,317, against 361,362,546 in 1948, and freight proceeds were 7,902,515, against 6,519,114 in 1948. Delta's net profit and its expense loads decreased during the year, its expense dropping 28.1 percent to 5,592,190 and its profit percentage was 3.2 percent to 4,514,305 in 1949.

Miami Airport Shows Big Profit

With easy money in the field still in the red and showing higher loss for commercial users in 1948, Miami International Airport announced a whopping \$151,207 net profit for the year ended last Sept. 30.

The airport, which boasts the largest passenger terminal in the world, reported a net profit of \$1,294,677 in fiscal 1949. Bulk of the income—\$771,739—was from rental of hangars, terminals and drop buildings to the airlines, but \$329,516 was derived from fees, \$127,301 from various non-aircraft and \$75,655 from services performed for tenants.

The four U.S. trunklines serving Miami—Eastern, Pan American, National and Delta—accounted for 70 percent of the profit in the past year with 980 passengers being lost. Pan

American, Eastern and National have large overhead and maintenance bases at Miami, where the mild climate permits them to cut expenses by doing 75 percent of the work outdoors.

► **Hope Expressway Underway**—With officials predicting a doubling of traffic within the next few years, Miami International Airport has initiated a \$110-million building program. Private interests have agreed to erect a \$8 million hotel-terminal building. Running expressway will be extended and a new 4.5-mile N.W. 52nd highway is planned. Trucks of the Seaboard Air Line Railroad, which now haul the north-south carway, will be relocated.

Notwithstanding its class A-top position among the nation's metropolitan airports, the Miami field posted to the 215,146 passengers by and from foreign points who used the field in first-half 1949. Total international passengers at LaGuardia Field during the same period numbered 161,415.

► **Heavy Cargo Movement**—First-half 1949 saw 16,903,940 lb. of air cargo move into and out of the country through Miami International Airport, compared with 5,947,578 lb. for LaGuardia.

The Miami field's passenger total in first-half 1949 (both foreign and domestic) was 571,640, against 514,297 for the same 1948 period. Air cargo totals in the first six months of last year were 18,983,000 lb., compared with 22,331,000 lb. in first-half 1948.

Two-Class Service

(McGraw-Hill World News)
West Atlantic Airways Corp. plans to offer a new, premium service which it inaugurates regular service between Asen, Gold Coast, and Khartoum, Sudan, with two-engine Bristol Wayliner aircraft only this year. Plans in the interim—how long will be able to carry 16 first-class passengers, 12 second-class passengers and 14 tons of freight.

Feederline Hits 525-hp. Continentals

Continental is introducing the 525-hp. Continental in March, 1949, were caused in large part by available performance of Continental R9A engines in the company's Beech D18C two-seater, officials of the feederline charged the month.

Appearing at a Civil Aeronautics Board hearing which will determine a final rule for Florida, President Joseph L. Dyer introduced exhibits designed to show that the 525-hp. Continental in his company's four D-18C's suffered a failure every 355 hr., whereas



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STRICTLY PERSONAL

TODAY'S CONTRIBUTION TO SCIENCE—Lt. Cmdr. Robert E. Fording, formerly of Washington, sent us: "As an avid reader of *AVIATION*, and particularly *STRIPTEASE*, I feel the padded missile coverage is a little weak. Enclosed is a copy of a report that has been making the rounds of the aerospace 'circle.' Since *Reader's Digest* is attached to the advanced technologies of the Joint Long Range Penetration General at Cocoa, Fla., I must know where to send it. We accept letters but have our latest contributions to scientific knowledge.

PROCESS REPORT ON SOLI (CCCN)

Coon No. 256 was severely lashed at 10-14 Nov. 7, 1949 using the acc. RS-7 (rubber sling) catapult. The purpose of this lashing was to test upon full stabilization under the conditions of 37.6 deg. relative wind, 80 percent humidity, 74 deg F temperature, and 29.96 in. barometric pressure.

Elephants were shot at 30 days age (with tube at 2) days. Mammals were wing and wing. The new Brown Mk. 1 camera was installed in a spring mounted, lens covered, heat based box of rubber. Mammal type at this capturing was installed. The camera was recovered, although it was still (to a ball the see of a walnut), and the film was recovered, exposed, and broken into approximately 300 pieces. Mammals are being compiled, however, and a report should be forthcoming early in 1952.

Booster ignition occurred permanently when the pump at No. 3 Gate inadvertently switched on its table radio on a frequency of 27.12 kHz cycle. Steps are being taken to keep all station radios off this frequency in the future.

The Gator quivered in place for five seconds, moved ahead two feet, spun around twice, and then wound down the outboard at an angle of attack of 45 deg, reaching an end speed of 62 mph. The Cam E-type 74-and-Raman-crafts bowster separated cleanly after hanging by No. 6 slacker for seven seconds.

The vehicle was then observed to roll slowly to the left 50 deg. at the same time going into a 47 deg. turn to the right and executing a zig-zag pattern similar to the Thatch Waver, otherwise stability appeared consistent with observations.

As the missile approached the western boundary of the firing area, the American chase plane was ordered to shoot it down. The crash occurred 1674 yards from the launching point.

The new Mine Recovery Unit from the Hoover-Vannoy Machine Co. was used to crush the ore and at the present time of going to press, 18,299 pieces have been recovered and carefully examined. It is now believed that the unsifted ore, iron and pyrite was caused by a 0.0016 in. sheet pin on the counter-rotating link of the hydraulic separator being shaken loose when the launching operator suffered a spasm of coughing. Steps are being taken to install a new shear pin of 0.0017 in. diameter and all launching operators have been ordered to smoke Old Gold.

WUXIAI: ALL ABOUT THE SIDE-GOING MACHINE.—We like this literal translation of parts of two stories from a Japanese newspaper, which we took from the *Sfanying News*. Translation was by the Air Rescue Service in Washington.

The breivogel which we saw at Lazon is the newest type H6 Ipad Steamship, helicopter of darning dark yellow. The two up 2000 cc. one run down at the hole. Our were able on it besides a pilot. But one was enough to push or pull it. Weight of this plane is 2900 pounds. It can fly continuously for five hours. So it has not so much difference with the Ford car. It has two operating levers. Using the revolution in it, they can adjust up and down and the speed accordingly to the propeller at the top. According to turning of the propeller which is fixed to the side at the rear tail operated by the controlling lever, it turned each one and it can even do the side going thing.

"It is said that the man who was hit at the time of setting sail of the ship chased the ship with the helicopter from the land, or some crew who left something in the float bar back saying 'Choote Matri' (Just a minute)." —R. H. W.

WHAT'S NEW

New Books

"Electronic Navigation" by Leonard M. Ducas, Lt Col U.S. Army. In this book, the author, director of the Army naval laboratory at West Point, details the entire field of electronics as related to aircraft and marine navigation. Described are how radar and laser are used for position fixing, and the many new derivatives are surveyed, including the radio altimeter, ILS and CCA, the forthcoming omni-line computers, DME, omniguage, tri-co, slant, R-Tra navigation, and British developments such as Ducas, ast, and comat.

There is a comprehensive glossary of terms used in electronics, 160 short questions with answers, and a bibliography. Published jointly by Pan American Navigation Service, 13321 Ventura Blvd., No Hollywood, Calif. and Western Systems of Navigation, Annapolis, Md. 222 pages, price \$4.95.

"Jet Aids Simplified" by Charles E. Clapp explains step-by-step the basic principles and practical applications of aircraft jet propulsion in conventional and turbofan engines. All types of engines are described and evaluated, including the turbojet, propjet, turbofan, turboprop, and composite engine arrangements. More than 100 jet engines and aircraft are illustrated and there is a comprehensive index. Published by Aero Publishers Inc., 2162 Sunset Blvd., Los Angeles, Calif., 90064, paper, pp. \$17.95 (hard cover)—\$27.95 (flexible cover).

New Literature

Directory of Shell Airport Dealers is a handy, pocket-size booklet listing companies' dealers throughout U.S. and Canada and giving grades of aviation oil and greases owned. Also included is a digest of state laws affecting tax on aviation fuels, listing amount of tax, and refund or exemption regulations for each state. Available by writing Shell Oil Co., aviation department, 30 W. 50 St., New York, N.Y.

Isolates on embedded were counter type of electrically heated silicon glass dishes, including most of product. Areal also from B. F. Goodrich Co., Akron, Ohio.

Series of five publications "Adjustable Speed", "Adjustable Speed AC Motor", "Speed Variator", "Electronic Speed Variator", and "The Mo-Trol Adjustable Speed Drive", are available in working General Electric Co., Silverdale, N. Y.

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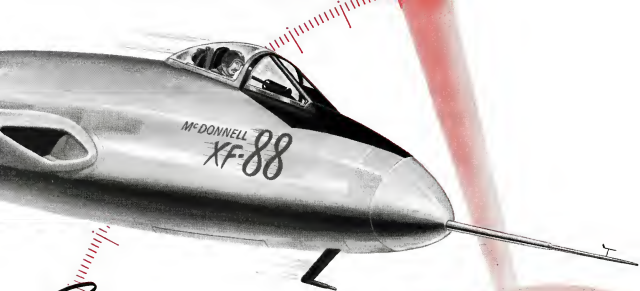
The attached scratchboard drawing is good -- but you still don't show the detail and precision that we build into these gears.

John L. Beuchler



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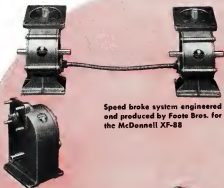
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Landing gear actuators on the Boeing B-47, B-50 and C-97—product of Foote Bros.

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